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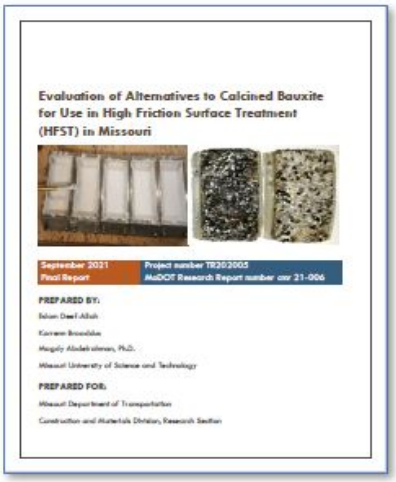
Research Summary

Evaluation of Alternatives to Calcined Bauxite for HFST in Missouri



High Friction Surface Treatment (HFST) can enhance the ability of a road surface to provide pavement friction to vehicles in critical braking or cornering maneuvers. MoDOT has used HFST since 2013 to restore pavement surface friction where traffic has worn down pavement surface aggregates and to improve wet crash locations. Currently, Calcined Bauxite is the primary aggregate used for HFST in Missouri. Calcined Bauxite has very limited sources, which make it more expensive than locally available aggregates. This research evaluated Calcined Bauxite's alternative aggregates through a comprehensive experimental program for use in HFST applications. The alternative aggregates were Earthworks, Meramec River Aggregate, Steel Slag, Rhyolite, Black Diabase, Quartzite, Flint Chat, and Potosi Dolomite.

Three categories of testing were followed in the experimental program: the first category was for the physical properties testing, the second category was for durability testing, and the third category was for performance testing. Physical testing included aggregate gradation, specific gravity & absorption, and uncompacted void content of fine aggregates. Durability testing included los Angeles abrasion, Micro-Deval (MD) polishing; discussed under performance testing, sodium sulfate soundness, water-alcohol freeze thaw, and acid-insoluble residue. Physical properties and durability tests were run to classify the aggregates and identify the routine tests that investigate the performance of the proposed aggregates as HFST materials. Performance testing included MD polishing, Aggregate Image Measurement System (AIMS), dynamic friction testing, and British Pendulum (BP) testing. The MD results reflected the aggregates' resistances to polishing and abrasion. The AIMS explored the changes that occurred to the Texture (TX) and Angularity (GA) indices for the coarse aggregates before, after 105-, and after 180-minutes polishing times in MD. The Dynamic Friction Tester (DFT) examined the Coefficient of Friction (COF) values before and after polishing cycles at different speeds. The polishing process was conducted using the three-wheel polishing device. Finally, the BP evaluated the aggregates' surface frictional properties before and after 10-hr polishing time using the British wheel.

"Meramec River Aggregate, Earthworks, and Steel Slag were the most favorable alternative to Calcined Bauxite."

The researchers developed a Life Cycle Cost (LCC) simple process using Excel to calculate the Net Present Value (NPV) for HFST applications based on AIMS, DFT, or BP results. The major input data for the LCC program were categorized into material and project specifics. Performance prediction models were used to convert the input data into Skid Number (SN)

values. The predicted terminal SN was compared with the recommended terminal SN using rehabilitation matrix. This matrix was proposed based on the predicted and recommended terminal SN values. Finally, the output data were calculated; these data presented the NPVs for the HFST applications. Based on the lowest NPV, the best HFST application was selected.

Meramec River Aggregate, Earthworks, and Steel Slag were the most favorable alternative to Calcined Bauxite. No relationships were detected between MD mass losses and AIMS TX or GA indices. No specific relationships were found between BP and AIMS results, and no significant relationships were found between AIMS and DFT results. The relationship between the BP and DFT results before the polishing processes illustrated that aggregate source with the highest COF value had the highest British pendulum number value (e.g., Calcined Bauxite). After the polishing processes, no specific relationship was detected between the BP and DFT results.

Based on cost analysis, Flint Chat and Meramec River Aggregate had the lowest NPVs followed by Steel Slag and then Earthworks. Contrarily, Rhyolite showed the highest NPVs followed by Calcined Bauxite. The high initial cost of Calcined Bauxite affected its NPV compared to other aggregate sources.

Prepared aggregate coupons used in the BP testing.

Project Information

PROJECT NAME: TR202005–Evaluation of Alternatives to Calcined Bauxite for HFST in Missouri

PROJECT START/END DATE: November 22, 2019-September 1, 2021

PROJECT COST: $116,974

LEAD CONTRACTOR: Missouri University of Science and Technology

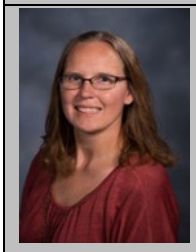
PRINCIPAL INVESTIGATOR: Dr. Magdy Abdelrahman

REPORT NAME: Calcined Bauxite Possible Alternative Aggregates for Use in Missouri High Friction Surface Treatment

REPORT NUMBER: cmr 21-006

REPORT DATE: September 2021

Project Manager



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